Before the
Federal Communications Commission
Washington, D.C.

In the Matter of	)	
	)	
Revision of the Commission's Rules	)	CC Docket No. 94-102
To Ensure Compatibility with	)	
Enhanced 911 Emergency Calling Systems	)	

Enhanced 9-1-1 Phase II Technology Report of Western Wireless Corporation

I. Introduction

Western Wireless Corporation ("Western Wireless") hereby submits this Report on its implementation plans for Enhanced 9-1-1 ("E911") Phase II technology, pursuant to the Commission's *Fourth Memorandum Opinion and Order*.[1] In its *Fourth Memorandum Opinion and Order,* the Commission requested that carriers report on November 9, 2000 their choice of technology, handset-based or network-based, and their schedule for deployment to achieve compliance with the Phase II location accuracy standards.

Western intends to select a network-based E911 technology to meet the Commission's Phase II accuracy standards, which will allow the Company to implement an approach that addresses the unique issues presented in providing Phase II service in rural markets and in more populated urban markets.

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1 In the Matter of Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems, Fourth Memorandum Opinion and Order, CC Docket No. 94-102, FCC 00-326 (released September 8, 2000 (*Fourth Memorandum Opinion and Order*).

II. Background/Contact Information

A. Western Wireless Markets

Western Wireless operates cellular systems in 19 western states under the Cellular One® brand name, serving over 900,000 subscribers in 18 Metropolitan Service Areas ("MSA") and 83 Rural Service Areas ("RSA") cellular markets. Within its licensed area, Western Wireless serves a population of approximately nine million people and 25% of the geography of continental United States. A map of the markets served by Western Wireless is shown below.

Figure 1. Cellular Markets Served by Western Wireless (as of 11/9/00).

B. Characteristics of Western Wireless' Service Area

Western Wireless' service area is very rural with an average population density of 10 people per square mile. Western Wireless does serve some communities with a population that exceeds 100,000 and a population density of 200 per square mile. However, the vast majority of Western Wireless' service area has a population density of less than 2.9 people per square mile. Looking further at the population distribution within its service area, 50% of the total population within Western Wireless' service area is distributed over 3.1% of its coverage area or approximately 30,000 square miles. Most major metropolitan areas do not equal a coverage area of 30,000 square miles. Figure 2, below, illustrates the distribution of population in Western Wireless' markets.

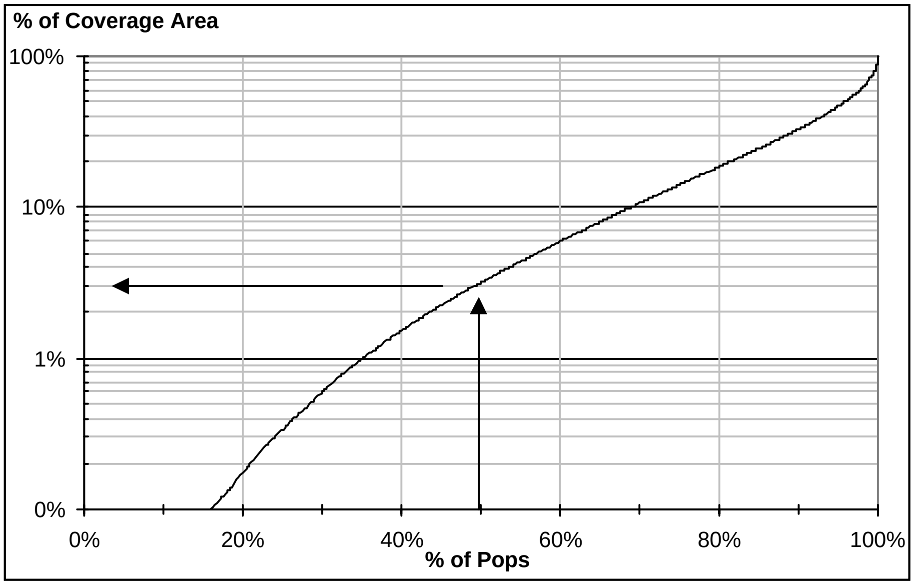

Figure 2. Western Wireless' Coverage area and Population

C. Carrier Identifying Information

Holding Company Name: Western Wireless Corporation

Carrier Names and TRS Numbers:

Billings Cellular Corporation:	808814
Cellular Corporation of Sioux Falls:	806019
Minnesota Cellular Corporation:	817876
WWC Holding Co., Inc.:	808809
WWC License Corporation:	805958
WWC Midland License Corporation:	806010
WWC Odessa Limited Partnership:	817874
WWC Texas RSA, L.P.:	817878

D. Contact Information

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E. Western Wireless' Experience With Phase II E911 Service

Western Wireless has proactively sought out solutions to the Commission's E911 mandates and has worked with local emergency providers to implement E911 Phase I service. Western Wireless has evaluated various E911 Phase II solutions potentially capable of meeting the Commission's accuracy standards. The Company has participated in a technical trial of a Phase II service and has analyzed experimental location concepts not yet in full commercial development.

In 1997, Western Wireless entered into an agreement to provide access, space, facilities, and information to US Wireless Corp. ("US Wireless") for the development and trial of location services in Billings, Montana. This trial included the coordination and participation of the State of Montana, US West Communications, Inc. (now Qwest), Nortel Networks, XYPoint Corporation, Williams Communications Solutions, Combix 9-1-1 Specialists, ISD Information Services Division, US Wireless, Western Wireless, and the Billings 9-1-1 Center. The first alpha trial of US Wireless' location technology in Billings took place in late 1998. Western Wireless' network infrastructure and participation was an integral part of the technology demonstration. In May 2000, the final report on the Phase II location technology trial was issued by the State of Montana.

As an initial step toward Phase II deployment, Western entered into a contract with SCC Communications Corp. to provide Phase I E911 services in markets where the emergency service provider is capable of receiving the Phase I location information. Western Wireless has deployed Phase I E911 service in several of its markets. As of November 9, 2000 Western has received official requests for Phase I service from five states: Texas, Colorado, Montana, Nebraska and South Dakota. Western Wireless is currently providing Phase I service in Texas and is in the process of deploying service in areas of the remaining states. Throughout many rural markets the majority of PSAPs do not have the upgraded infrastructure necessary to receive and utilize the ANI and p-ALI Phase I information. Western is committed to working with counties to deploy both Phase I and Phase II service, and will likewise comply with phase II deployment requirements.

III. E911 Phase II Location Technology Information

A. Technology Selection:

In its *Fourth Memorandum Opinion and* Order, the Commission required that all carriers declare the technological solution that will be deployed in their network to meet the revised Phase II location identification accuracy standards. Broadly speaking, there are only two Phase II technology solutions: handset-based and network-based. Each solution has unique strengths and weaknesses that vary based upon the wireless technology that is used and the service area in which it is used. These solutions are summarized below from the perspective of a rural cellular service provider.

B. Handset

The handset-based solution involves equipping a mobile phone handset with a Global Positioning Satellite ("GPS") component capable of communicating with orbiting satellites to determine location identification. To accomplish this each handset must be equipped with both a GPS chip and a GPS antenna. Subscribers must replace or upgrade their phones at a significant cost relative to a non-GPS phone. Phones enhanced with GPS functionality are physically larger, will consume more power, causing battery life to be shorter, and will cost more than non-GPS equipment.

In Western Wireless' service area, approximately 30% of its customers reside in very rural areas where the use of 3-watt Advanced Mobile Phone Service ("AMPS") (analog) equipment is either preferred or required. At this time no handset manufacturer or vendor has indicated the availability of 3-watt GPS enabled equipment. Without the appropriate GPS equipment, a handset-based solution for Phase II E911 that meets the Commission's accuracy standards would be difficult, if not impossible, to achieve.

Another factor in deciding whether to deploy a handset or network based solution is how best to support roaming customers with Phase II service. This is a particularly difficult problem with a handset solution in that there is no guarantee that roaming customers will have a GPS enabled phone. In a handset-based environment, Western would be unable to transmit the ANI and ALI information for a person roaming without a GPS-enabled phone onto Western's network.

C. Network

Network-based solutions do not require handset upgrades or modification. Instead, the network-based solution requires that additional equipment be added to the infrastructure of the network. This solution works with the existing handset equipment that all customers already own and allows for the convenient retention of legacy customer equipment, and also supports every roaming customer who comes onto the network.

In urban density populated areas, where there are many overlapping cell sites, a more precise determination of the location of a mobile user can be realized. However, in more rural areas, such as 98% of the Western Wireless coverage area, there is typically no overlapping coverage and therefore it is more difficult to determine the precise location of mobile customers.[2]

IV. E911 Phase II Trial Information

A. Handset-Based Solution

Western Wireless did not participate in any technical trial of a handset-based solution, but did review and analyze publicly available data on handset-based trials.

B. Network-Based Solution

Western Wireless has conducted extensive phase II E911 testing with US Wireless utilizing the "Radio Camera" product.

1. Test environments

The coverage area selected for the Montana Wireless E9-1-1 Trial encompassed approximately 25 square miles including downtown Billings, MT and the surrounding residential, industrial and suburban / rural regions. Within this coverage area, a total of

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[2] Some network-based technologies substitute overlapping coverage with extensive drive testing and calibration of the coverage area. The calibration creates a type of technological "fingerprint" for the potentially multiple paths of radio frequency signals. For Western Wireless' rural network, this solution would require detailed drive testing of roughly 97,000,000 square miles of terrain.

22 fixed test points and 9 mobile test routes were selected for the performance evaluation. These test points and routes were chosen to uniformly sample the test area and to provide a balanced cross section of the types of environments found in that region. The selected test points and mobile routes are shown in figure 1 and figure 2 respectively. For purposes of evaluation and comparison, subsets of the test points and routes were combined to form four representative operating environments. These operating environments are defined as (1) Light Urban, (2) Industrial, (3) Residential, and (4) Suburban / Rural.

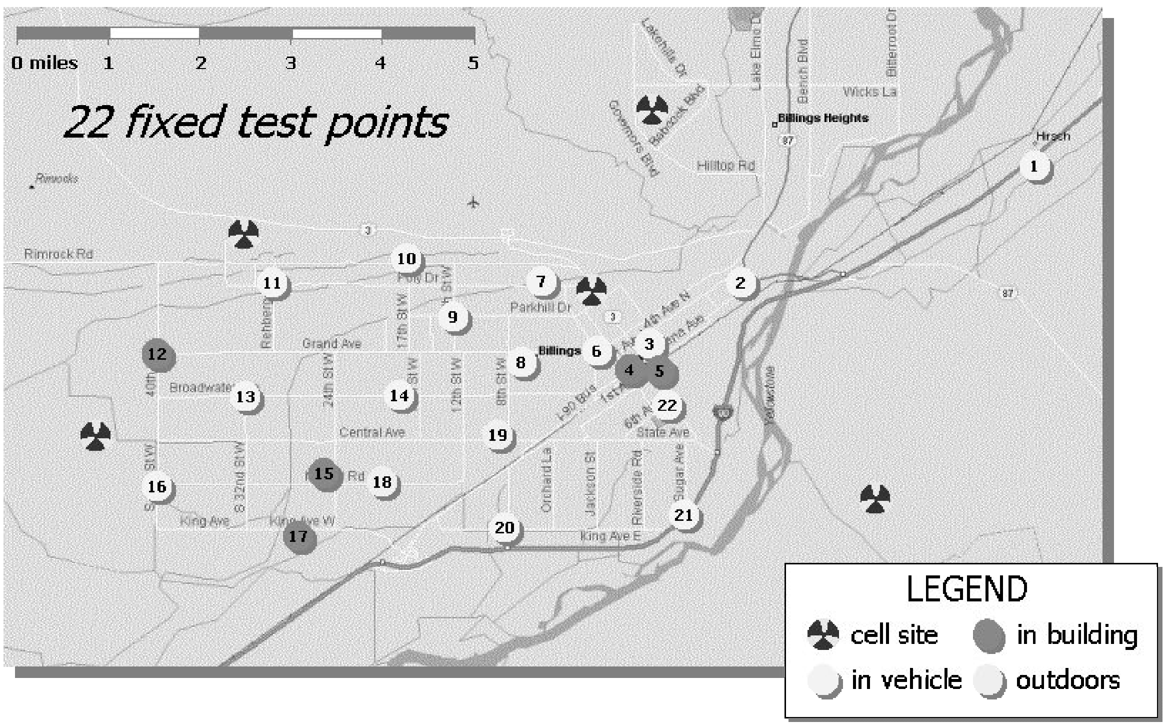


Figure 3. Fixed test points.

[redacted]

Figure 4. Mobile test routes.

2. Location Accuracy Performance Results

Location accuracy is reported as a function of latency. As with most location systems, accuracy can be substantially improved if longer observation periods are permitted. By using a quality (confidence) measure, the system can determine which of the fixes measured during a given observation period is best, and report only that location.

In this analysis, the observation period is permitted to range from 1 fix period (approximately 3 seconds) up to 15 fix periods (approximately 45 seconds). This analysis was performed for each of the four test environments (light urban, industrial, residential, suburban / rural), as well as the combined environments. In each case, two figures are used to present the results:

Left figure – location accuracy: 67th percentile accuracy vs. latency performance

Right figure – location accuracy as the percentage of fixes within 100m of the actual location

White curve – performance achieved by the location fix with the highest quality factor

Dark gray curve – optimal performance achieved by choosing the best location estimate in the observation interval, regardless of the confidence factor. This curve represents the type of performance that might be achieved if the quality factor estimation was completely optimized.

Figures 5, 6, and 7, below, show the results of various test environments.

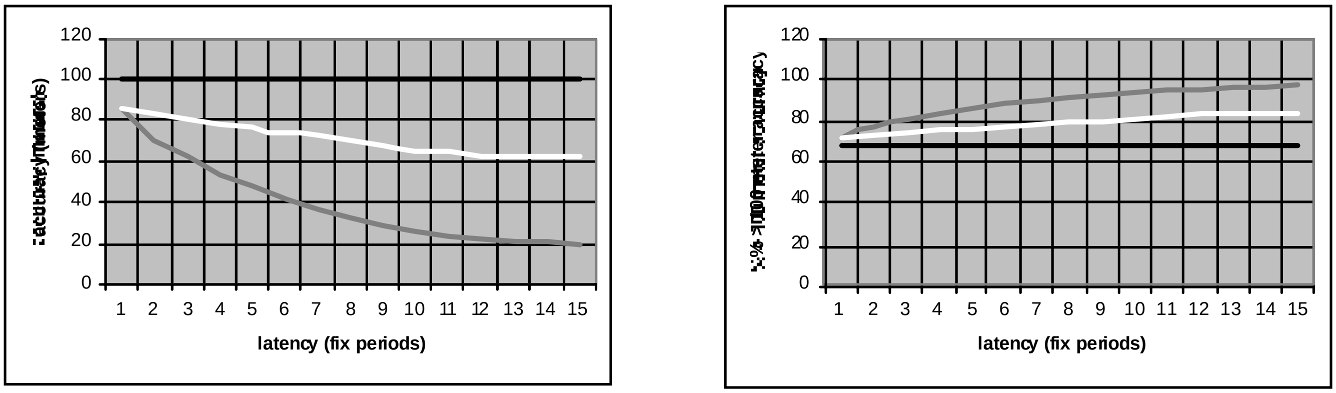


Figure 5. Combined environments, Stage III.

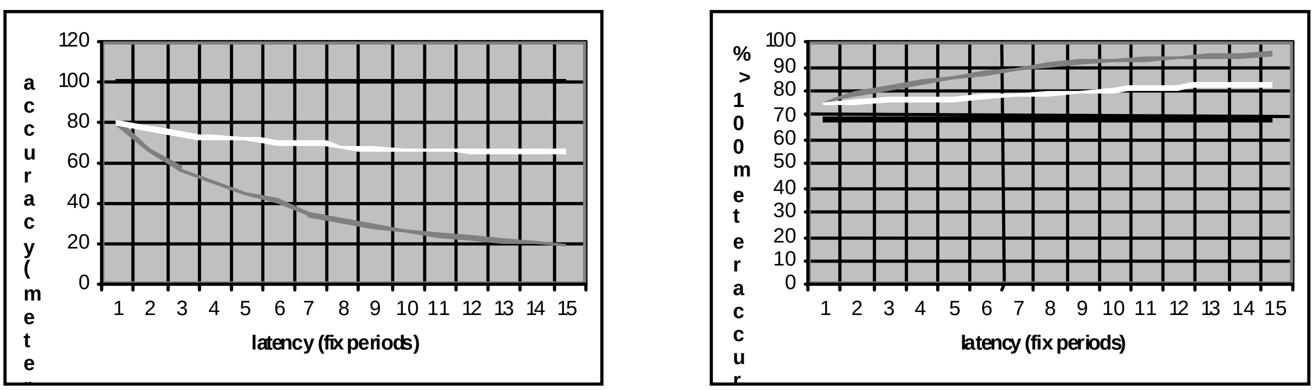
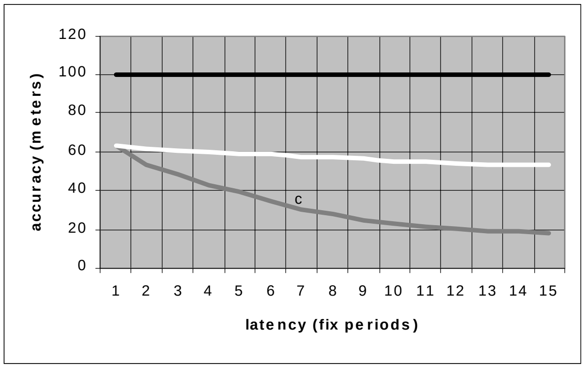


Figure 6. Residential environment, Stage III.



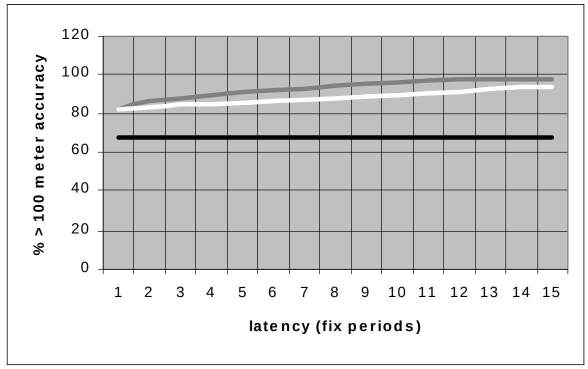


Figure 7. Suburban / Rural environment, Stage III.

C. Current Location Trial Summary

All of the trials conducted in the public domain were conducted in urban areas with a high cell site density and close cell site spacing. In this environment, there are nearly always multiple cell sites that cover the same area. This improves the accuracy of all network based location technologies. Based on these trials, it appears that a more precise location determination can be achieved in urban areas.

V. E911 Phase II in Rural Areas

In the Western Wireless Billings trial, testing was conducted to estimate the performance of the US Wireless system under extreme rural conditions (low-population density) that represent roughly 98.7% of the Western Wireless coverage area. Approximately 98.7% of Western's coverage area can be classified as extremely rural with a population density of less than 7.7 people per square mile. This area, nearly 950,000 square miles, is characterized by very large individual cell coverage areas with little overlapping coverage and a very dispersed population. The average coverage area per site is 830 square miles. In the urbanized 1.3% of Western's service area, the average coverage per cell is 87 square miles. These factors make any type of accurate location solution very difficult. Large cell coverage areas make location calibration nearly impossible due to the need to calibrate vast areas of land that have no paved roads. Additionally, minimal overlapping coverage makes triangulation solutions problematic since any valid location calculation requires coverage from at least three sites.

Several off grid (uncalibrated) rural performance tests were conducted in the Billings trial. In, figure 8, typical static off grid performance is shown as 1800 meters. In, figure 9, typical mobile off grid performance is shown as 2400 meters. In both cases, the error could range anywhere from 0 meters to the indicated error based on the location of other cell sites, terrain, travel speed and propagation conditions.

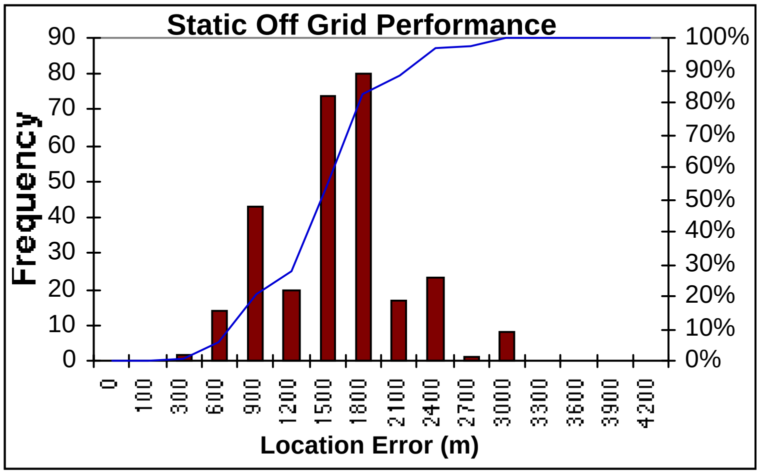


Figure 8. Typical static off grid performance.

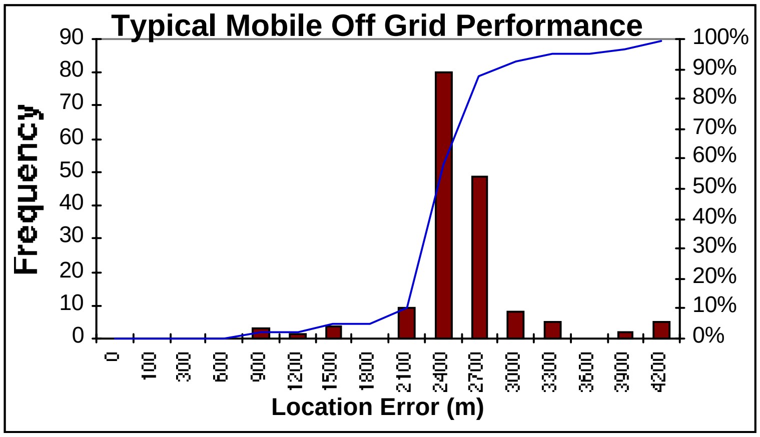


Figure 9. Typical mobile off grid performance.

This reduction in location accuracy is common to all network based location systems in sparse deployment and large cell site conditions. For calibration-based systems, the error increases as one moves further away from the calibrated area. For angle of arrival-based systems, the error increases as one moves further away from the site and the angular error becomes a larger position error. For time difference of arrival based systems, the error increases as geometry of widely dispersed sites makes triangulation more difficult. Typical error performance, for calibration-based systems, is shown above.

VI. Location Technology Declaration and Implementation Schedule

Western Wireless intends to utilize a network based location system in order to be able to serve our rural customer base, our roaming customer base and our large deployed base of AMPS 3-watt subscriber equipment.

Western Wireless will continue its process of deploying E911 Phase II systems by issuing an RFP before December 20, 2000. A contract is expected to be in place by March 1, 2001 with deployment in areas with valid E911 Phase II requests by October 1, 2001.